Seismic Retrofitting of Buildings

Full Mitigation Best Practice Story

Santa Barbara County, California

Santa Barbara, CA - For many older facilities, one mitigation option to protect against seismic hazards is the seismic rehabilitation of existing structural elements. An example of the benefit of such mitigation measures can be found through an analysis of the case of North Hall at the University of California at Santa Barbara.

The North Hall facility is a three-story reinforced concrete structure, designed and built in 1960. It was originally thought that the building was designed to the 1958 seismic load resistance building code, which did not prescribe the more modern types of earthquake resistant construction. However, a 1973 engineering investigation discovered that the building was instead designed for only one-tenth of the 1958 requirements, creating unsafe conditions at the facility.

Fortunately, the construction work to correct the original design errors occurred at about the same time that the Uniform Building Code was being revised to include substantial earthquake resistance provisions. The facility was partially rebuilt in 1975 by adding interior and exterior shear walls to provide additional seismic resistance. The decision was then made to rebuild the structure according to the provisions of the revised building code; the upgrade made the North Hall Building the only building on campus built to that advanced level of seismic standards.

The 1976 cost of the seismic retrofit was $288,000 for this three-story building with a total floor area of 24,480 square feet. Thus, the cost of the retrofit was $11.76 per square foot. The 1976 cost of replacing the building would have been about $60 per square foot. Thus, the retrofit cost was about 20 percent of the replacement cost. Present replacement costs for this building would be about $150 per square foot.

The timing of the work could not have been better. In 1978, approximately 2 years after work was complete, an earthquake struck Santa Barbara. Because the mitigation work had been completed on the North Hall, the damage to that structure was very minor, and did not impact structural integrity. By contrast, substantial damage was sustained by the unretrofitted buildings on the campus that were not built to the provisions of the new building code. Total damage to unretrofitted buildings on the University campus alone came to over $3.8 million. On the basis of direct costs alone, retrofitting to the provisions of the 1976 building code proved to be cost-effective.

Activity/Project Location	
Geographical Area:	**Single County in a State**
FEMA Region:	**Region IX**
State:	**California**
County:	**Santa Barbara County**
City/Community:	**Santa Barbara**

Key Activity/Project Information

Sector:	**Public**
Hazard Type:	**Earthquake**
Activity/Project Type:	**Retrofitting, Structural**
Activity/Project Start Date:	**06/1975**
Activity/Project End Date:	**06/1976**
Funding Source:	**Private funds; State sources**
Funding Recipient:	**Critical Facility - School**
Funding Recipient Name:	**University of California at Santa Barbara**

Activity/Project Economic Analysis

Cost:	**$288,000.00 (Estimated)**

Activity/Project Disaster Information

Mitigation Resulted From Federal Disaster?	**No**
Value Tested By Disaster?	**Yes**
Tested By Federal Disaster #:	**No Federal Disaster specified**
Year First Tested:	**1978**
Repetitive Loss Property?	**Unknown**

Reference URLs

Reference URL 1:	**http://neic.usgs.gov/**
Reference URL 2:	**http://www.oes.ca.gov/Operational/OESHome.nsf/1?OpenForm**

Main Points

- A 1973 engineering investigation discovered that the 1960 building was designed for only one-tenth of the 1958 requirements.
- The facility was partially rebuilt in 1975 by adding interior and exterior shear walls to provide additional seismic resistance. The decision was then made to rebuild the structure according to the provisions of the revised building code; the upgrade made the North Hall Building the only building on campus built to that advanced level of seismic standards.
- Because the mitigation work had been completed on the North Hall, the damage to that structure was very minor, and did not impact structural integrity. By contrast, substantial damage was sustained by the unretrofitted buildings on the campus that were not built to the provisions of the new building code.